Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

THE SUBPROVINCIAL LIMITATIONS OF PRE-CAMBRIAN NOMENCLATURE IN THE ST. LAWRENCE BASIN

M. E. WILSON[1]
Canadian Geological Survey, Ottawa, Canada

INTRODUCTION

The detailed geological work carried on in recent years throughout the southern part of the Canadian pre-Cambrian shield has shown that the geological succession in the ancient terranes of this territory is regionally less uniform and includes a greater number of rock series than was formerly supposed. Moreover, it has become evident that the widespread correlations implied by the use of the same nomenclature nearly everywhere throughout this great pre-Cambrian province assumes much more with regard to the regional succession in these ancient rocks than is actually known.

Although it is not possible generally to demonstrate with mathematical conclusiveness that geological formations occurring in different localities are equivalent, nevertheless the premature use of the same name for formations, the correlation of which is open to question, or the continued use of the same name for formations after it has become evident that their correlation is in doubt, is misleading, and is an obstacle rather than an aid in geological investigation. Hypothetical correlations of groups of rocks occurring in widely separated districts may serve for comparison or as a stimulus to investigation, but all the advantages of such tentative correlations may be attained by using a general terminology (Proterozoic, Archaeozoic, etc.) and thereby avoiding the definite correlations implied in the use of names of local origin. In the pre-Cambrian province which occupies the northern part of the St. Lawrence River basin there are four geographically and geologically separate subprovinces: (1) the region northwest of

---

[1] Published with the permission of the Director of the Geological Survey of Canada.

Lake Superior, (2) the region south of Lake Superior, (3) the region extending northeastward from Lake Superior and Lake Huron to Lake Timiskaming and Lake Mistassini, and (4) eastern Ontario and the lower St. Lawrence, with which might be included the Adirondack region. With the possible exception of some of the late pre-Cambrian series occuring in the Lake Superior and the Timiskaming subprovinces, the evidence upon which the rocks of these separate regions can be correlated is exceedingly meager, and for the present, at least, the only logical course would seem to be to build up a separate nomenclature in these various subprovinces by using those names already defined in these localities, supplemented by such local new names as become necessary from time to time as geological investigation is continued.

OBJECTIONS TO AN INTER-SUBPROVINCIAL NOMENCLATURE

The widespread correlations implied in the use of a common nomenclature throughout all the pre-Cambrian subprovinces of the St. Lawrence basin has been based on the assumption that the succession of formations within the various subprovinces has been worked out to practical completeness, and on the application of certain principles by which the correlation of the various formations in these widely separated areas is presumed to be established. The purpose of the following discussion is to point out that the assumption that our knowledge of the succession of formations in any of the subprovinces is complete is open to question and that the principles by which pre-Cambrian rocks are generally correlated are in part inapplicable and as a whole quite inadequate for the establishment of a pre-Cambrian nomenclature embracing all the territory in the St. Lawrence basin in which pre-Cambrian rocks occur.

OUR KNOWLEDGE OF THE SUCCESSION OF FORMATIONS IN THE SUBPROVINCES INCOMPLETE

The numerous regional classifications of the pre-Cambrian rocks of the St. Lawrence basin which have appeared from time to time in recent years, and the use of such terms as Keewatin, Laurentian, and Huronian nearly everywhere throughout this great pre-

Cambrian province and at points hundreds of miles from those in which these names were originally defined, would seem to imply that our knowledge of the succession of formations within this vast territory was much more complete than is actually the case. Only a very small part of the territory in the St. Lawrence basin in which pre-Cambrian rocks occur has been actually mapped in detail, and even in those localities which have been mapped in considerable detail and have been regarded in the past as type areas the succession of formations formerly supposed to be present has in many cases been considerably modified by more recent investigation.[1]

THE PRINCIPLES OF PRE-CAMBRIAN CORRELATION INAPPLICABLE OR INADEQUATE

Continuity or approximate continuity of outcrop.—The principle of continuity, or approximate continuity, of outcrop is the most conclusive of all the means by which the relationship of rocks can be determined. But it is inapplicable to the correlation of the various rock series occurring in the different pre-Cambrian subprovinces for the reason that these are geographically and in part geologically separate from one another. Between the Timiskaming and the Grenville subprovinces there intervenes an extended belt of banded gneisses; between the Timiskaming and the western subprovinces there are the little-known wooded pre-Cambrian highlands on the north and overlapping Paleozoic sediments on the south; and between the northwestern and the southwestern subprovinces lie the waters of Lake Superior. If, therefore, a common nomenclature be employed for all the pre-Cambrian subprovinces of the St. Lawrence basin, this nomenclature must be based on other less conclusive principles of correlation.

Lithological similarity.—This criterion has been widely applied in the correlation of pre-Cambrian formations, although it is in reality of very limited application; for the pre-Cambrian rocks of the Canadian shield, both sedimentary and igneous, are for the most part common types which might be deposited or intruded or extruded in any epoch of earth history. It has been largely on the basis of this principle that the name Keewatin, first applied by Lawson to the metamorphosed basal volcanic complex occurring in the region northwest of Lake Superior, was extended, first to the Timiskaming region and later to eastern Ontario, a district nearly 1,000 miles distant from the locality in which the term was originally defined; yet volcanic rocks of this character are among the most common in the earth's crust. They are represented at some point in nearly all the pre-Cambrian series of the St. Lawrence basin; are likewise abundant in later formations throughout the world, as in Great Britain, where they occur at numerous horizons ranging in age from the early Palaeozoic to the Tertiary; and are in process of formation at one or more points on the earth's surface today. As a consequence of this unscientific method of correlation the name Keewatin, although presumed to represent a definite formation, in reality is now applied in the Canadian pre-Cambrian subprovinces to any highly metamorphosed volcanic rock without regard to age.

---

[1] A. C. Lawson, *Geol. Surv. Can., Mem. 28*, 1912, and *Mem. 40*, 1913, p. 4.

W. G. Miller and C. W. Knight, *Ann. Rep. Ont. Bureau of Mines*, XXII, Part 2, 1914.

R. C. Allen and L. P. Barrett, *Jour. Geol.*, XXIII (1915), 689.

W. H. Collins, *Geol. Surv. Can., Sum. Rept.*, 1916, p. 183.

C. R. Leith and R. C. Allen, *Jour. Geol.*, XXIII, 703.

Similar stratigraphical succession of beds.—The larger part of the pre-Cambrian surface rocks of the region under consideration are volcanic flows or clastic sediments, in which a regular sequence of strata is uncommon, and this criterion is therefore inapplicable except to the late pre-Cambrian rocks. It has been especially useful in the mapping of the Huronian series in the Timiskaming subprovince, the Lower Marquette in the region south of Lake Superior, and the Animikie sediments in the region northwest of Lake Superior.

Similar serial succession.—The widespread correlation implied in the nomenclature applied to the pre-Cambrian rocks of the St. Lawrence basin has been based to a considerable extent on this principle, although the apparent similarity in the serial succession may very frequently be explained in other ways. The principal objection to the use of this criterion is that it neglects to consider the possibility of overlap. Sedimentary rock series are not generally deposited continuously or uniformly over immense areas, and where they have been deposited they are very commonly swept away in part by later erosion, before succeeding series are laid down. Moreover, the pre-Cambrian surface rocks are to a large extent volcanic flows or land sediments, and on this account are much more discontinuous than sediments of marine origin.

Mode of origin of formations.—This criterion is of limited application; for sediments originating in the same way may be deposited during different geological epochs, and likewise sediments originating in different ways may be deposited contemporaneously in adjoining localities. It might be of value in the correlation of certain uncommon types, such as glacial deposits, which generally occur only at long intervals in geological time.

Relationship to batholithic intrusions.—The relationship of the pre-Cambrian surface rocks to the great epochs of batholithic invasion is of great assistance in correlation and may possibly eventually prove to be the most important of all the criteria used in the classification of the pre-Cambrian rock series into major groups; for geological investigation throughout the world has shown that batholithic intrusions are an accompaniment of mountain-building movements in the earth's crust, and are thus directly related to the great regional changes in rock structure, to regional metamorphism, and to the uplifts which give rise to the great erosion intervals which form the dividing lines between the great pre-Cambrian terranes. Some of the applications and limitations of batholithic invasion in rock correlation are included in the following:

Batholithic massifs are co-extensive with the mountains they underlie, and since mountains are generally extensive and linear the massif should also be extensive and linear. The extent of the outcrop of the massif will depend, of course, on the extent to which unroofing has been carried. In the Rocky Mountains, for example, unroofing has apparently only begun; in the Coast Range batholith of the Pacific Coast, on the other hand, unroofing is almost complete; and in some of the pre-Cambrian batholiths of the Canadian shield not only is the unroofing largely completed, but the batholith has also been reduced to base level.

If two batholithic massifs have been intruded in a given region the younger may displace the first. Hence the conspicuous structural features of the region would be those of the younger massif, and all evidence of the former presence of the older batholith might be destroyed except for such remnants as happened to remain in association with the roof rocks in the geosynclinal belts.

Mountain-building periods and hence also periods of batholithic intrusion occur at long intervals separated by erosion periods and the development of peneplains.

The rocks in the vicinity of an intrusive batholithic mass are generally highly folded and metamorphosed; hence, if in a given area in the vicinity of a batholith flat-lying rocks occur which have not been greatly metamorphosed, it may be inferred that they have not been intruded by the batholith.

Batholiths are composite, and their intrusions continue during long intervals of time so that their various parts are only approximately of the same age.

Batholithic rocks are lithologically so similar that it is generally impossible to distinguish between batholiths of different ages except by means of their relationships to other rocks of which the age is known.

Recently A. C. Lawson has contributed an interesting paper to the discussion on the "Correlation of the pre-Cambrian Rocks of the Region of the Great Lakes," in which he formulates the hypothesis that throughout the region extending from the Adirondacks to northwestern Ontario there were in pre-Cambrian time "two and only two periods in which great granitic batholiths were developed in the earth's crust." On the basis of this hypothesis he correlates all the pre-Cambrian rocks occurring in the territory to which his hypothesis is applied.[1] This hypothesis, if true, would undoubtedly greatly simplify the problems of pre-Cambrian nomenclature and correlation in the region under discussion; but an examination of the hypothesis from either a deductive or an inductive standpoint seems to indicate that it is an unwarranted assumption.

The principal fact on which Lawson's hypothesis of two and only two periods of granitic batholithic intrusion was based was that at the time the hypothesis was formulated only two periods

[1] *University of California Publications*, X (1916), 1–19.

of batholithic intrusion had been recognized in most of the pre-Cambrian subprovinces of the St. Lawrence basin. There is a very apparent reason, however, why two and only two batholithic intrusions can be recognized in a single locality, namely, that if a third batholith were intruded in a district where two batholiths were already present the evidence of the former presence of one or other of the older batholiths would probably disappear.[1]

If it be assumed that batholithic intrusions represent the interior portions of mountain chains it is obvious that the prolonged erosion, which generally follows an orogenic uplift, must inevitably result in the stripping off of the roof rocks from the underlying massif and the replacement of surface rocks by plutonic types in the district where the uplift has occurred; also that successive crustal movements of the orogenic type in the same or adjoining localities must eventually bring about the disappearance of all trace of rocks originally present in such zones of disturbance. It is probable that within the base-leveled pre-Cambrian complex which underlies the larger part of the Canadian shield evidence of the presence of more than two separate periods of batholithic intrusion would not generally survive in a single locality. If, however, the succession of formations can be determined over an extended area, as where less metamorphosed late pre-Cambrian sediments occur, the number of batholithic intrusions which can be recognized might be increased. Thus, as a result of the more extended areal geological studies of recent years, evidence is accumulating that at least three definite periods of batholithic invasion are represented in several of the pre-Cambrian subprovinces of the St. Lawrence basin.

The folded and metamorphosed pre-Cambrian rocks occurring along the southern margin of the Canadian shield have in the main a northeasterly structural trend; likewise the granitic batholiths, so far as their areal distribution has been determined, are distributed in northeasterly trending zones; thus the region (approximately 1,000 miles in length) extending from the Adirondacks to the Lake of the Woods, to which Lawson's hypothesis has been applied, lies almost transverse to the regional trend of pre-Cambrian folding, mountain building, and batholithic invasion. Moreover, mountain systems throughout the world are generally narrow and linear and, where zones of crustal disturbance composed of several mountain systems, such as the cordillera of North America, occur, the systems composing the zone are generally of varying age. Hence, if granitic massifs represent the interior of mountain systems exposed by denudation, it is more probable that the northeasterly trending pre-Cambrian batholithic zones of the St. Lawrence basin, instead of belonging to two and only two periods of batholithic intrusion, in reality represent several periods of batholithic development.

---

[1] A. C. Lane, *Am. Jour. Sci.*, XLIII (1917), 42.

Relationship to igneous intrusions other than batholith.—Igneous intrusions other than batholiths, especially if they are composed of unique rock types, can likewise be employed for purposes of correlation, but generally only within a single subprovince. The principle has been used for inter-subprovincial correlation in the case of the late pre-Cambrian diabase intrusions, however, all of which have been generally regarded as Keweenawan in age.

Folding and metamorphism.—Since folding and metamorphism are accompaniments of mountain building and batholithic invasion, these criteria are in reality included under the head, "Relationship to Batholithic Intrusions." It can be generally inferred that in the same district those rocks which are most highly folded and metamorphosed are the oldest in age. This does not follow in the case of widely separated regions, however; for it has been found that rocks which are flat-lying and slightly metamorphosed in one district may be highly folded, metamorphosed, and intruded by granite batholiths in another locality.

CONCLUSION

From the preceding discussion the following conclusions may be inferred: that the regional succession of formations within the pre-Cambrian of the St. Lawrence basin has not yet been sufficiently worked out for the establishment of a definite nomenclature applicable to the whole of this territory; that, since the St. Lawrence basin extends for approximately 1,000 miles in a direction transverse to the trend of pre-Cambrian mountain building and batholithic intrusion, it is theoretically improbable that the geological history of the various parts of this territory in pre-Cambrian time would be the same; that the geological succession of formations so far determined to be present in these various parts indicates that their history has not been the same; that the pre-Cambrian formations occurring in the St. Lawrence basin fall naturally into a number of separate subprovinces; and that it is advisable for the present that a separate nomenclature be employed in each of these subprovinces.

The principal advantages that might be attributed to the widespread correlations implied in the present nomenclature applied to the pre-Cambrian rocks of the St. Lawrence basin are that they serve as tentative hypotheses for the investigator in the field, and as summaries of existing knowledge for the science as a whole. But it is doubtful whether tentative hypotheses have a place in geological nomenclature, and furthermore, for the investigator familiar with the facts in the field, tentative correlation tables indicating the most probable relationships of the formations occurring in the various subprovinces can afford all the advantages of a regional nomenclature, and for those not familiar with the facts in the field a general classification from which names of local origin are excluded could be used. Such a classification might be less definite, but it would be scientific, since it would express what is actually known, or what is at least generally accepted, by those familiar with the facts in the field rather than tentative hypotheses.